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U.S. PATENT APPLICATION

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Invention: VEHICULAR ANOMALY DIAGNOSIS SYSTEM

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SPECIFICATION

VEHICULAR ANOMALY DIAGNOSIS SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This application is based on and incorporates herein by reference Japanese Patent Application No. 2002-341080 filed on November 25, 2002.

FIELD OF THE INVENTION

The present invention relates to a vehicular anomaly diagnosis system for diagnosing a function of beforehand detecting an engine start of a vehicle. Here, the engine start is beforehand detected, for instance, when a door is opened and closed or a driver seats himself on a driver seat. Warming up an engine or components relating to the engine is executed prior to the engine start when the engine start is beforehand detected.

BACKGROUND OF THE INVENTION

Patent Application Publication of USP-2002/0005178 A1 discloses that a heat accumulating device is provided for executing warming-up of an engine of a vehicle prior to a engine start. The engine start is beforehand detected through opening and closing of a door or manipulation of an ignition key as a preparation operation to the engine start. The engine is then warmed up using the heat accumulating device prior to the engine start. Here, in particular, the engine start is prohibited till the warming-up is completed. The warming-up using the heat accumulating device is thereby securely executed.

However, failure of a function for detecting the preparation operation to the engine start naturally leads to incapability of detecting the preparation operation. Accordingly, the warming-up of the engine cannot be executed before the engine starts. Reducing emission thereby becomes difficult due to starting of the engine in low temperature.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a vehicular anomaly diagnosis system capable of detecting failure of a function for beforehand detecting a start of an engine of a vehicle.

To achieve the above object, an anomaly diagnosis system is provided with the following. Warming-up of one of an engine and a component relating to the engine can be executed. A pre-start state is detected by detecting a preparation operation for a start of the engine. Here, the warming-up is beforehand executed prior to the start of the engine when the pre-start state is detected. Furthermore, anomaly of the pre-start state can be detected. This structure of detecting the anomaly of the pre-start state enables notification to the driver of the anomaly or output the anomaly into a terminal for maintenance in such as a maintenance shop. Unfavorable situation where the engine or the related components cannot be pre-heated prior to the engine start can be thereby restricted and emission can be also restricted.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features, and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a diagram showing a schematic overall structure of an embodiment of the present invention;

FIG. 2 is a flowchart diagram explaining processing of beforehand detecting of an engine start;

FIG. 3 is a flowchart diagram explaining processing for a main relay control unit to start an ECU;

FIG. 4 is a flowchart diagram explaining processing of pre-heating a heater of an air/fuel ratio sensor till a driver actually starts an engine;

FIG. 5 is a flowchart diagram explaining seat switch failure detection that is processing of detecting failure when a driver is seated;

FIG. 6 is a flowchart diagram explaining seat switch failure detection that is processing of detecting failure when a driver is not seated; and

FIG. 7 is a flowchart diagram explaining processing of stopping an ECU.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a schematic overall structure of an engine control unit (ECU) 1 according to an embodiment of the present invention. In this embodiment, the ECU 1 receives, as

information of an engine of a vehicle (not shown), signals of cooling water temperature 29, air/fuel ratio 30, and the like 21 to 28, via a main relay control unit 11 that is to be described. Based on the received plural signals, the ECU 1 executes engine control by outputting, into plural actuators (not shown), signals for controlling the engine.

When an air/fuel ratio sensor (not shown) remains in low temperature at engine start, feedback control cannot be executed even after the engine start. The engine control cannot be thereby executed based on an air/fuel ratio, so that restricting emission becomes difficult. Therefore, the engine start is beforehand detected based on opening/closing of a door or sitting down on a driver seat. From then, warming-up is beforehand executed with using a heater of an air/fuel ratio sensor till a driver actually starts the engine. This leads to enhancing an activated state of the air/fuel ratio sensor prior to the engine start in comparison with a case where the engine is started in low temperature. The feedback control is thereby quickly executed, so that the emission can be restricted.

The ECU 1 is equipped with the main relay control unit 11 for controlling a main relay 3. The main relay control unit 11 detects, through switches 4 to 9 or based on the signals 21 to 30, preparation operations (to engine start) that indicate that the engine is about to be started. When the preparation operation is detected, the ECU 1 is started to control the air/fuel ratio sensor heater 10 for executing the warming-up of the air/fuel sensor till the engine start.

The switches 4 to 9 shown in FIG. 1 are as follows: an ignition switch 4 that is switched among OFF, ON, and START positions when a driver turns a key; an ignition insertion switch 5 that is turned into an ON state when the driver inserts the key; a door-lock drive switch 6 that is turned into an ON state when a door-lock of the vehicle is driven; a door-knob manipulation switch 7 that is turned into an ON state when a door-knob is opened; a door opening/closing switch 8 that is turned into an ON state when a door is opened; and a seat switch 9 that is turned into an ON state when a driver is seated on a driver seat.

In a case where a detection function of preparation operation that detects the preparation operation fails, the warming-up of the air/fuel ratio sensor heater 10 is started only when the driver turns the key for the ignition switch to be switched into the START position. Namely, the air/fuel ratio sensor is not pre-heated, so that the feedback control is not started for a while and restricting the emission thereby becomes difficult. Accordingly, an object of the embodiment is to quickly detect the failure of the detection function of preparation operation to engine start.

Processing relating to detecting the failure of the detection function will be explained below with reference to FIGs. 2 to 7.

FIG. 2 shows processing of beforehand detecting of an engine start or of detecting a preparation operation. At Step 100, it is determined whether a state of being not seated shifts

into a state of being seated based on a state of the seat switch 9. Here, the state of being not seated is a state where no driver is seated on the driver seat, while the state of being seated is a state where a driver is seated on the driver seat. When the state of being not seated is determined to not shift, the routine is terminated with bypassing Step 101. Otherwise, when the state of being not seated is determined to shift, the processing proceeds to Step 101. Here, since it is assumed that a preparation operation to engine start is detected, a pre-heat trigger is outputted as a signal indicating start for heating of an air/fuel ratio sensor (pre-heating). The routine is then terminated.

The above-mentioned processing is executed through hardware structure when the seat switch 9 is turned into an ON state. Namely, when the seat switch 9 is turned into an ON state, a battery 2 and the main relay control unit 11 are electrically connected with each other. Electric power of the battery 2 is then supplied to the main relay control unit 11. The main relay control unit 11 thereby determines that the pre-heating trigger is inputted.

In the next place, processing that the main relay control unit 11 executes for starting the ECU 1 will be explained with reference to FIG. 3. At Step 110, it is determined whether the pre-heat trigger is inputted. When the pre-heat trigger is not inputted, the processing proceeds to Step 111 where it is determined whether an ignition switch 4 is in an ON position. When the ignition switch 4 is not in the ON

position, the routine is terminated. Otherwise, when the ignition switch 4 is in the ON position, the processing proceeds to Step 112, where the main relay control unit 11 starts the main relay 3. The ECU 1 is thereby started at Step 113.

When the ECU 1 is started, the air/fuel ratio sensor heater 10 is pre-heated by a driver for a period till the engine is actually started. A starter is to be started for starting the engine according to a state of pre-heating.

Processing of the ECU 1 will be explained with reference to FIG. 4. When the ECU 1 is started, pre-heating of the air/fuel ratio sensor heater 10 starts at Step 120. At Step 121, it is then determined whether the ignition switch 4 is set in START position. When the ignition switch 4 is set in the START position, the processing proceeds to Step 122. Here, it is determined whether a necessary period for heating the air/fuel ratio sensor elapses after the pre-heating starts. When the necessary period does not elapse, the processing returns to Step 121 and the above-mentioned processing is repeated.

When the necessary period elapses, the processing proceeds to Step 123. Here, a starter (not shown) is compulsorily started to start the engine and the routine is then terminated.

By contrast, when the ignition switch 4 is not in the START position, the processing proceeds to Step 124. Here, it is determined whether a given period elapses after the pre-heating starts. The given period is set as being longer than the above necessary period. For instance, it can be set by considering

consumption of the power of the battery 2 in a case where the engine is not actually started for a while.

When the given period does not elapse, the processing returns to Step 121 and the above processing is repeated. Otherwise, when the given period elapses, the processing proceeds to Step 125. Here, the power supply to the air/fuel ratio sensor heater 10 is stopped to stop the pre-heating, and the routine is then terminated.

As explained above, in this routine, as the ECU 1 is started, the pre-heating is started. Even when the ignition switch 4 is in the START position, the engine start is awaited till the pre-heating is completed. When the pre-heating is completed, the engine is started. The air/fuel ratio sensor is thereby properly activated at the engine start, so that emission at the engine start can be restricted due to the feedback control. By contrast, when the ignition switch 4 is not in the START position, the pre-heating is started just after starting the ECU 1. However, when the pre-heating is completed and nevertheless the engine is yet to be started, the pre-heating is stopped after the given period. The over-consumption of the power of battery 2 can be thereby restricted.

In the next place, a feature of this embodiment will be explained with reference to FIG. 5. In detail, it is processing of diagnosing failure of a function for beforehand detecting engine start. This routine shows failure diagnosis of the seat switch 9 while a driver is seated on a seat. A state where a driver is not seated on a seat even when a vehicle travels

determines that the seat switch 9 fails.

At Step 130, it is determined whether a period for which a vehicle speed 21 (shown in FIG. 1) exceeds a given speed is equal to a given period or above. The given speed can be a speed at which a vehicle does not stop. When the period is less than the given period, the routine is terminated.

By contrast, when the period is not less than the given period, the vehicle is determined to be traveling. The processing proceeds to Step 131, where it is determined whether a driver is seated on a seat. When the driver is determined to be seated, the processing proceeds to Step 133. Here, since the driver is seated while the vehicle is traveling, it is determined to be normal and the routine is then terminated. Otherwise, when the driver is determined to be not seated, the processing proceeds to Step 132. Here, it is determined to be abnormal and the routine is then terminated.

In the next place, failure diagnosis while a driver is not seated on a seat will be explained with reference to FIG. 6. In this diagnosis, the seat switch 9 is determined to fail when the seat switch 9 indicates the presence of the driver on the seat even after the driver retires from the vehicle.

At Step 150, it is determined whether the ignition switch 4 is in an OFF position. While it is not in the OFF position, the processing at Step 150 is repeated. When it is in the OFF position, the processing proceeds to Step 151.

At Step 151, it is determined whether the ignition key is drawn off from an ignition insertion switch 5. When the

ignition key is not drawn off, the processing at Step 151 is repeated. When the ignition key is drawn off, the processing proceeds to Step 152.

At Step 152, it is determined through the door opening/closing switch 8 whether a door is opened and closed. When the door is not opened nor closed, the processing at Step 152 is repeated. When the door is opened and closed, the processing proceeds to Step 153.

At Step 153, it is determined through the door-lock drive switch 6 whether a door-lock is executed from an outside of the vehicle. When the door-lock is not executed from the outside, the processing at Step 153 is repeated. When the door-lock is executed from the outside, the processing proceeds to Step 154.

In the processing from Step 150 till Step 154, usual operations that a driver executes from stopping an engine to retiring from the vehicle are determined. In particular, when the door-lock is determined to be executed from the outside of the vehicle at Step 153, the driver is never seated on the seat. Accordingly, at Step 154, it is determined through the seat switch 9 whether the driver is seated on the seat. When the driver is determined to be not seated, the seat switch 9 is determined to be normal at Step 155 and the routine is then terminated. When the driver is determined to be seated, the seat switch 9 is determined to be abnormal at Step 156 and the routine is then terminated.

In the above-mentioned routine, the failure diagnosis is

conducted on the seat switch 9 after the driver stops the engine. The ECU 1 is therefore needed to be running even when the driver stops the engine. Processing from stopping of the engine by the driver to stopping of the ECU 1 will be explained with reference to FIG. 7.

When at Step 140 the ignition switch 4 is affirmatively determined to be in an OFF position, the processing proceeds to Step 141. Otherwise, the processing at Step 140 is repeated. At Step 141, it is determined whether the failure diagnosis of the seat switch 9 explained in FIG. 6 is completed. When the failure diagnosis is completed, the processing proceeds to Step 143. Here, the ECU 1 is stopped and the routine is then terminated.

By contrast, the failure diagnosis is not completed, the processing proceeds to Step 142. Here, it is determined whether a given period elapses after the failure diagnosis starts. The given period is set for preventing over-consumption of the power of battery 2 even in an abnormal case where the failure diagnosis continues to be conducted without a stop.

When the given period does not elapse, the processing at Step 142 is repeated for awaiting the completion of the failure diagnosis. Otherwise, when the given period elapses, the processing proceeds to Step 143. Here, the ECU 1 is compulsorily stopped for preventing the over-consumption of the power of battery 2 and the routine is then terminated.

As explained above, in this embodiment, the preparation operation to engine start is predicted based on the seat switch 9. Here, in a case where the seat switch 9 is by failure fixed

in an ON or OFF state, it is not detected whether a driver is seated on a seat. The failure of the seat switch 9 is required to be notified to the driver by the failure diagnosis of the seat switch 9. As a result, replacement of the component relating to the failure of the seat switch 9 can be completed, so that no prediction of the engine start can be avoided. The engine is not thereby started in a condition where the air/fuel ratio sensor is not heated. This results in restricting deteriorating of the emission.

(Modification 1)

In the above embodiment, whether a driver operates a vehicle is determined by whether a vehicle speed 21 exceeds a given speed at Step 130 in FIG. 5. Anomaly of the seat switch is determined when the seat switch indicates that no driver is seated even while the driver is operating the vehicle. In this embodiment, whether a driver operates a vehicle is determined by one of the following conditions: a condition is that an engine rotation speed 22 that is detected by a clunk sensor or the like is equal to a given speed or above; a condition is that an amount 23 of air that is sucked to the engine is equal to a given amount or above; a condition is that a pressure 24 detected by a suction pressure sensor provided in an exhaust path is equal to a given pressure or above; a condition is that an opening degree 25 of an accelerator operated by a driver is equal to a given degree or above; a condition is that an opening degree 26 of a throttle is equal to a given degree or above; a condition is that an amount 27 of stepping of a brake pedal is

equal to a given amount or above; and a condition is that an amount 28 of stepping of a clutch pedal is equal to a given amount or above. (The parameters 22 to 28 used in the conditions are shown in FIG. 1.) The above conditions can be used for determining by using each of the conditions or by using a combination of plural conditions.

(Modification 2)

In the above embodiment, anomaly of the seat switch 9 is determined when the seat switch 9 indicates that no driver is seated while the driver operates the vehicle. However, in a case where the seat switch 9 may malfunction due to electric noise while the driver operates the vehicle, it is mistakenly determined that no driver is seated on a seat. Therefore, in this embodiment, when an abnormal state continues for a given period, the anomaly of the seat switch 9 is finally determined. This restricts mistakenly diagnosing anomaly even when the electric noise affects the seat switch 9.

The anomaly of the seat switch 9 can be also finally determined when an anomaly counter exceeds a given count. Here, the anomaly counter is continuously incremented while the anomaly is being detected.

(Modification 3)

In the above embodiment, an ON or OFF state of the seat switch 9 is used for detecting a preparation operation and anomaly of the seat switch 9 is determined by comparing a state of the seat switch 9 with a state where a vehicle is operated. However, in this embodiment, a preparation operation is detected

based on whether an ignition key is inserted. By contrast, the vehicle is determined to be being operated when the ignition key is in an ON position or START position. Namely, when an ignition key insertion switch 5 is in an ON state and an ignition key 5 is in an ON position or in a START position, the ignition key insertion switch is normal. A function of detecting a preparation operation to engine start is thereby determined to be normal. By contrast, when an ignition key insertion switch 5 is in an ON state and an ignition key is neither in an ON position nor in a START position, the ignition key insertion switch 5 is abnormal. A function of detecting a preparation operation to engine start is thereby determined to be abnormal.

As explained above, failure diagnosis can be also conducted on a function of detecting a preparation operation based on the ignition key insertion switch 5.

In this embodiment, whether a vehicle is being operated can be also detected based on one of the following conditions: a condition is that a vehicle speed 21 is equal to a given speed or above; a condition is that an engine rotation speed 22 that is detected by a clunk sensor or the like is equal to a given speed or above; a condition is that an amount 23 of air that is sucked to the engine is equal to a given amount or above; a condition is that a pressure 24 detected by a suction pressure sensor provided in an exhaust path is equal to a given pressure or above; a condition is that an opening degree 25 of an accelerator operated by a driver is equal to a given degree or above; a condition is that an opening degree 26 of a throttle is

equal to a given degree or above; a condition is that an amount 27 of stepping of a brake pedal is equal to a given amount or above; and a condition is that an amount 28 of stepping of a clutch pedal is equal to a given amount or above.

(Modification 4)

In the preceding embodiment, a preparation operation is detected based on whether an ignition key is inserted. However, in this embodiment, a preparation operation is detected based on an ON/OFF signal of a door opening/closing switch 8. Here, when a driver retires from a vehicle by opening and closing a door, a door-knob is also manipulated. Accordingly, in this embodiment, whether a door is actually opened and closed is determined based on an ON and OFF signals of the door-knob manipulation switch 7. Therefore, anomaly of the door opening/closing switch 8 is determined when the ON/OFF signals of the door opening/closing switch 8 are not detected for a period including time when the ON and OFF signals of the door-knob manipulation switch 7 are detected. Anomaly of a function of detecting a preparation operation to engine start can be thereby detected.

By contrast, the door opening/closing switch 8 as a target of a preparation operation can be substituted by the door-knob manipulation switch 7. Namely, a preparation operation to engine start is detected based on an ON/OFF signal of a door-knob manipulation switch 7. Anomaly of the door-knob manipulation switch 7 is determined when the ON/OFF signals of the door-knob manipulation switch 7 are not detected for a period including time when the ON and OFF signals of the door

opening/closing switch 8 are detected.

(Modification 5)

In the above embodiments, failure diagnosis is conducted on a function of a preparation operation to engine start. In addition to that, when the anomaly is detected, a history of the anomaly can be stored in a backup RAM within the ECU 1.

(Modification 6)

In the above embodiments, the processing of failure detection is executed as shown in FIGs. 5, 6. However, in this embodiment, the processing of the failure diagnosis can be repeatedly continued till the failure diagnosis is eventually completed. Furthermore, when the failure diagnosis cannot be completed after a given period, the failure diagnosis can be compulsorily interrupted.

(Modification 7)

In the above embodiments, an air/fuel ratio sensor heater 10 provided in an air/fuel ratio sensor is pre-heated. However, when a suction pipe heater 31 is provided for heating a suction pipe, warming-up can be executed by controlling an electric current flowing through the suction pipe heater 31. Furthermore, a heater 32, 33, 34 can be provided in at least one of the following: a catalyst converter provided in the exhaust gas path for purifying harmful gas; a fuel injection valve provided for injecting fuel into the engine; and a canister provided for adsorbing vapor fuel vaporized from a fuel tank. The above heaters 31 to 34 are shown in FIG. 1.

Furthermore, each of the above-mentioned embodiments can

be also used as a combination with another embodiment within the embodiments.

It will be obvious to those skilled in the art that various changes may be made in the above-described embodiments of the present invention. However, the scope of the present invention should be determined by the following claims.